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Fumigation Handbook

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Program Handbook

September, 1987

Forward

The Fumigation Handbook transmits policies and procedures when the fumigation of grain is required as a result of (1) insect infestation found during loading, (2) contractual specifications, and (3) phytosanitary inspection certification.

The handbook provides official inspection personnel with basic information regarding fumigants and fumigation. The procedures in this Handbook supersede GR Instruction 918-6, Auxiliary 19, Revision 2, Shiphold Fumigation, dated 9/12/77, and FGIS Instruction 919-1, In-Transit Fumigation of Grain Aboard Tanker-Type Vessels, dated 4/21/82.

Procedures regarding the fumigation of railcars (both static and in transit) and the static fumigation of vessels will be included in this handbook at a later date.

John W. Marshall
Director
Field Management Division

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Federal Grain Inspection Service
Washington, D.C. 20250

FUMIGATION HANDBOOK
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CHAPTER 1

GENERAL INFORMATION

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This Handbook contains the Federal Grain Inspection Service (FGIS) policies and procedures for the fumigation of grain and certain other commodities. To successfully interpret and apply these policies and procedures, it is essential that FGIS and agency personnel become familiar with basic information regarding fumigants and fumigation.

1.1
DEFINITIONS

The following definitions relate to terms used in this Handbook or terms likely to be used by persons in or associated with the fumigation industry.

Aerosol - A suspension of liquid or solid particles of a chemical in the air. Unlike gases, these particles cannot penetrate commodities. Aerosols are often referred to as smokes, mists, or fogs.

Aluminum Hydroxide - The residue that remains after the decomposition of the fumigant aluminum phosphide. Small amounts of unreacted aluminum phosphide may also remain in the gray-white aluminum hydroxide dust. Aluminum hydroxide is a clay-like compound that is nonpoisonous.

Aluminum Phosphide - A chemical that reacts with moisture to release the fumigant, phosphine, or hydrogen phosphide. Aluminum phosphide fumigant formulations contain approximately 55 percent aluminum phosphide and 45 percent inert ingredients to regulate the release of the fumigant and suppress flammability. Inert ingredients may include ammonium carbamate, ammonium bicarbonate, urea, and paraffin.

Application Method - The process used to administer a fumigant formulation.

Certified Applicator - Any individual who is certified to use or supervise the use of any restricted use pesticide covered by their certification. This definition is contained in the Code of Federal Regulations (CFR)(40 CFR 171.2(h)) promulgated by the U.S. Environmental Protection Agency (EPA).

Concentration - The actual amount of fumigant present in the air space in any given part of the structure being fumigated at any given time.

Dosage - The amount of fumigant formulation applied, often expressed as the weight of the fumigant per volume of space treated or the weight of chemical per weight of commodity.

Fumigant - A chemical which, at the required temperature and pressure, exists in the gaseous state in sufficient concentrations to be lethal to a targeted pest.

Fumigant Formulation - The chemical or mixture of chemicals comprised of all active and inert (if any) ingredients which releases a fumigant. Fumigant formulations may exist in any of the three physical states: liquid, gas, or solid.

Fumigation - The action of releasing a toxic chemical in the gaseous state to control a targeted pest.

Gas - The state of matter distinguished from the solid and liquid states by very low density and viscosity, relatively great expansion and contraction with changes in pressure or temperature, the ability to diffuse readily, and the spontaneous tendency to become distributed uniformly throughout any container.

Granule - Finely divided chemical formulation as small particles. A granular formulation of aluminum phosphide is packaged in moisture permeable envelopes or sachets.

Hydrogen Phosphide - An alternate name for phosphine.

Parts By Volume - The relative number of gas molecules present in a given volume of air, such as parts per million (ppm) or parts per billion (ppb). These values are frequently used in human and mammalian toxicology and in applied industrial hygiene to indicate concentration.

Pellets - Aluminum phosphide formulated as a spherical-shaped mass 3/8 of an inch in diameter, weighing about 0.6 grams that releases 0.2 grams of phosphine.

Phosphine (PH_3) - A colorless, odorless gas having a low molecular weight, low boiling point, and specific gravity of 1.21 in relation to air. The gas diffuses rapidly and is capable of penetrating deeply into materials, such as bulk grains. Phosphine is flammable at concentrations above 1.79 percent by volume in air.

Recirculation - The act of moving a fumigant throughout a space being fumigated to prevent stratification and provide an even distribution of the fumigant. Usually accomplished with fans located inside or outside the fumigated space.

Restricted-Use Pesticide - A pesticide that is classified for restricted use under the provisions of Section 3(d)(1)(c) of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended (Pub. L. 92-516, 86 Stat. 973). Statements indicating that a pesticide is classified as "restricted use" must appear on the EPA approved label. Aluminum phosphide is classified as "restrictive use." Restricted use pesticides can only be used by or under the supervision of a certified applicator.

Residue - The active ingredient(s), metabolite(s), or degradation product(s) that can be detected after the use of a pesticide.

Residual Pesticide - A pesticide that is active only at or near the point of application and persists for extended periods in sufficient concentrations to be lethal to targeted pests. An example of a residual pesticide is malathion. Residual pesticides are often referred to as contact insecticides.

Sachet - A moisture permeable envelope containing aluminum phosphide in a granular formulation. Each sachet weighs approximately 34 grams and will release about 11 grams of phosphine. The envelopes may also be placed in cloth strips referred to as bag blankets or belts.

Specific Gravity (gas) - The weight of a gas compared to the weight of an equal volume of air under prescribed conditions of temperature and pressure. The specific gravity of phosphine gas is 1.21 with the value of air being 1.0. Therefore, phosphine is slightly heavier than air.

Tablet - Aluminum phosphide formulation in a spherical or flat and round shape weighing approximately 3 grams that releases approximately 1 gram of phosphine.

1.2
FUMIGANT
PROPERTIES

A. General. Fumigation is defined as the process of releasing and dispersing a toxic chemical that reaches a targeted pest in the gaseous state. An ideal fumigant should have the following characteristics:

1. Highly toxic to all life stages of the targeted pest.
2. Low toxicity to plants and humans and other nontarget organisms.
3. Readily available and economical to use.

4. Imparts no harmful residue to the commodity.
5. Easily detected warning properties.
6. Nonflammable, noncorrosive, and nonexplosive under normal application conditions.
7. Noninjurious to product quality, seed germination, or end use quality.
8. Highly volatile with excellent penetration properties and easy to aerate.
9. No adverse effect on the environment.

Unfortunately, no single fumigant has been developed that possesses all of these properties.

The efficiency of fumigants is influenced, in part, by the method of application. Fumigants may be applied singly or combined with other chemicals to improve efficacy or minimize potential hazards, such as flammability. For example, aluminum phosphide formulations contain one or more of the following: ammonium carbamate, ammonium bicarbonate, urea, and paraffin. These materials regulate release of phosphine and suppress flammability.

Fumigant formulations can be applied as a gas or solid. The commodity to be treated must be in a sealed enclosure to retain the fumigant for a sufficient length of time to control the target pest. Such sealed enclosures may include the use of wood, plastic, fiberglass, steel, or concrete.

Under the treatment situations covered in this Handbook, aluminum phosphide has proved successful in controlling all life stages of insects injurious to stored grain. Substantial research has been conducted to verify the safety and effectiveness of aluminum phosphide under various conditions. Aluminum phosphide has been selected based on its physical, chemical, and biological properties.

Table 1 presents some of the important properties of phosphine.

TABLE 1
Essential Properties of Phosphine

Molecular Weight	34.0
Boiling Point 1/	- 87.4C (-125.3F)
Specific Gravity 2/ (air = 1)	1.21
Lower Explosion Limit 3/	1.79%

Comments: Highly toxic, slightly heavier than air, excellent penetration properties, easy to aerate.

1/ Boiling point at 760 mm pressure.

2/ Values greater than 1.0 are heavier than air.

3/ Percent by volume of gas in air.

B. Aluminum Phosphide. Aluminum phosphide reacts with moisture in the air to produce phosphine (hydrogen phosphide) which is highly toxic to all forms of animal and human life. Phosphine is a colorless, odorless gas. However, an odor of carbide, decaying fish, or garlic occurs from contaminants as the aluminum phosphide produces phosphine. Aluminum phosphide formulations are composed of approximately 55 percent aluminum phosphide and 45 percent inert ingredients, such as ammonium carbamate, ammonium bicarbonate, urea, and paraffin.

Aluminum phosphide is manufactured in pellet, tablet, and granular formulations. The pellets weigh about 0.6 grams and release 0.2 grams of phosphine, and the tablets weigh approximately 3 grams and release 1 gram of phosphine. Pellets or tablets are often placed in moisture permeable enclosures to retain the residual dust. The granules are placed in moisture permeable envelopes, sachets, or bags which may in turn be placed in cloth strips, blankets or belts.

Each sachet weighs about 34 grams and releases about 11 grams of phosphine. The acceptable formulations and applications of aluminum phosphide listed in this Handbook employ the use of these three basic formulations.

When the aluminum phosphide formulations react with the moisture in the air, ammonia and carbon dioxide are released along with the phosphine. The formulations of aluminum phosphide react slowly to produce phosphine. Reaction of the formulation generally starts about 1-2 hours after exposure to the atmosphere. The rate of reaction varies with moisture and temperature and will take place quicker on days with higher moisture (humidity) and temperature.

When reaction of the aluminum phosphide with moisture is complete, a fine, gray-white powder remains. This powder is composed of nonpoisonous aluminum oxide hydrate and a small amount of unreacted aluminum phosphide. In bulk grain, this small amount of unreacted aluminum phosphide reacts quickly in the handling or unloading process without hazard to workers or leaving objectionable residues on the commodity. Several manufacturers have developed special packaging devices for pellets or tablets to retain the residual dust just as is the case with granules which are placed in envelopes, sachets, or bags. These packages allow easy removal of all residual dust after aeration of the commodity. These packages or other similar devices (designed to retain residual dust) are used for processed commodities, such as corn meal, flour, and milled rice, in order to meet the EPA requirement that under no condition shall any processed commodity come in contact with aluminum phosphide residues.

1.3 SAFETY

The fumigation policies and procedures contained in this Handbook are based on extensive research. In conducting the research, a major objective was the evaluation of safety for all parties involved with the fumigation. The results of the research studies have demonstrated the safety of the fumigation procedures contained herein.

In performing their responsibilities under this Handbook, official personnel should have no occasion for exposure to dangerous concentrations of fumigants. However, it is prudent that all official personnel be familiar with some basic safety precautions.

A. Restricted Use Pesticide. Perhaps the first level of safety is the classification of pesticides by EPA. In reviewing aluminum phosphide, EPA classified the fumigant as a restricted use pesticide. This means that only certified applicators can purchase and apply these fumigants.

B. Certified Applicator. A certified applicator is any individual who is certified by the proper licensing authority to use or supervise the use of any restricted use pesticides covered by their certification. Certification is defined by EPA as the recognition by a certifying agency that a person is competent and thus authorized to use or supervise the use of restricted use pesticides. The certification is conducted by individual State or local agencies under guidelines established by EPA. The certified applicator adds another measure of safety to the fumigation program by supervising individuals using restricted use pesticides.

C. EPA - Labeling. The EPA registers labeling for pesticides. By EPA regulation, each label must contain the following information:

1. The name, brand, or trademark under which the product is sold.
2. The name and address of the producer, registrant, or person for whom the product was produced.
3. The net contents (weight or measure) of the product.
4. The product registration and establishment number.
5. An ingredient statement listing the name and percentage by weight of each active ingredient and the total percentage by weight of all inert ingredients.
6. Warning or precautionary statement. The specific text is determined by the toxicity category of the pesticide established by EPA. There are four categories of toxicity. The most toxic category requires the use of the term "Danger," the next lower toxic category requires the term "Warning," and the two least toxic categories require the term "Caution" to appear on the label. In addition, since aluminum phosphide is in the most toxic category, a statement of practical medical treatment must also appear on the label.
7. Directions for use.
8. The use classification as to general or restricted use. Restricted use pesticides, such as aluminum phosphide, have the following statement on the label: "For retail sale to and use only by Certified

Applicators for those uses covered by the applicators certification or persons trained in accordance with the attached product manual working under the direct supervision and in the physical presence of the Certified Applicator."

The EPA labeling provides a great deal of useful information. All FGIS and agency personnel involved with the fumigation procedures in this Handbook should retain a copy of the label(s) for reference purposes and become familiar with the safety precautions listed on the label.

D. Symptoms of Exposure. Although there should be no occasion where FGIS or agency personnel encounter hazardous fumigant concentrations in implementing the procedures in this Handbook, it is advisable to be fully aware of the symptoms of exposure to phosphine.

SYMPTOMS OF EXPOSURE TO PHOSPHINE ARE:

1. Slight or mild poisoning which produces a feeling of fatigue, ringing in the ears, nausea, pressure in the chest, and uneasiness. All of these symptoms will normally disappear when the person is removed to fresh air.
2. Moderate exposure that leads to general fatigue, nausea, gastro-intestinal symptoms accompanied by vomiting, stomach ache, diarrhea, disturbance of equilibrium, strong pains in the chest, and difficulty in breathing.
3. Exposure to very high concentrations which rapidly produces strong difficulty in breathing, bluish-purple skin color, difficulty in walking or reaching, subnormal blood oxygen content, unconsciousness, and death. Death can be immediate or may be delayed until several days later.

E. Treatment. As discussed earlier, the EPA approved label contains information regarding practical treatment regimes. If any of the symptoms previously described are experienced, a physician should be contacted immediately. To expedite proper treatment, it is advisable to have a copy of the EPA approved label available for the physician. Generally, the most up-to-date information regarding medical treatment for exposure is available from the fumigant manufacturer. The EPA approved label contains the manufacturer or distributor's name, address, and phone number. FGIS field offices and agencies should maintain a list of emergency phone numbers including those of the nearest hospital and poison control center.

F. Exposure Limits. Exposure limits for various pesticides and other substances have been developed by several organizations. Since the exposure limits are continually reviewed, no exposure limits for aluminum phosphide are shown here. Current exposure limits for these fumigants may be obtained from the FGIS Safety Staff. Collateral duty safety and health officers should be aware of the latest exposure limits for aluminum phosphide.

CHAPTER 2

IN-TRANSIT FUMIGATION - VESSELS

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Attachment 3 Statement of Fumigant Application Compliance

2.1
POLICY

Based on the authority of section 800.86(e)(1) of the regulations under the United States Grain Standards Act, as amended, and applicable provisions of the Agricultural Marketing Act of 1946, when bulk grains or certain other commodities loaded aboard certain types of oceangoing vessels are found to be infested, the applicant shall be promptly notified and shall have the following options:

- A. Continue loading, in which case, a separate certificate will be issued for the quantity of grain determined to be infested and all other grain in common stowage with the infested grain;
- B. Offload the quantity of grain determined to be infested and an additional amount in common stowage; or
- C. Continue loading and fumigate the grain under official personnel observation and the provisions of this chapter. In such case, a certificate will be issued without the special grade designation weevily or infested.

The applicant may elect to use the procedures outlined here when in-transit fumigation is required by the buyer or seller or to fulfill phytosanitary requirements even though the grain or commodity is not found to be weevily or infested. Further, an applicant may request the official personnel witness such fumigations.

2.2
DEVELOPMENTAL
HISTORY

Since 1975, the Federal Grain Inspection Service (FGIS), in cooperation with the Agricultural Research Service (ARS) and the grain, fumigant, and maritime industries, has been involved with research studies to develop safe, effective, and economical fumigating methods for bulk grain while in transit aboard oceangoing vessels.

Based on the data obtained from these studies, ARS has provided FGIS with recommendations for the safe and effective in-transit fumigation of bulk grain aboard several types of vessels. Accordingly, FGIS has issued policies and procedures encompassing the in-transit fumigation of bulk grain aboard certain carriers using aluminum phosphide^{1/} fumigant formulations registered by the U.S. Environmental Protection Agency (EPA).

1/ Aluminum phosphide is the fumigant formulation, while phosphine is the toxic gas evolved from the formulation.

2.3
SCOPE

In-transit fumigation of bulk grain in vessels is approved only within the following parameters:

A. Acceptable Vessels. The vessel types approved for in-transit fumigation are:

1. Bulk dry-cargo vessels including oceangoing barges.
2. Tanker-type vessels.
3. Liquified natural gas (LNG) carriers converted to bulk carriers.
4. Lakers or 'tween deck vessels with the same structural characteristics as bulk dry cargo vessels.

These vessel types are acceptable only when a certified applicator ^{2/} states that the vessel has been inspected and found to be suitable for fumigation. Acceptable vessels must contain no interior bulkheads, structures, or decks within the tanks or holds which could impede the penetration of the phosphine gas throughout the grain mass. For example, a 'tween decker with decks made of steel grating may be fumigated provided the vessel is otherwise suitable for fumigation. Wing tanks on acceptable vessels may be fumigated under this chapter. If the wing tanks have bleeder holes connected to the main hold or tank and the bleeder holes remain open, the main hold or tank connected to the wing tank must also be fumigated.

B. Acceptable Bulk Commodities. Commodities that are acceptable for in-transit fumigation are: barley, corn, flaxseed, mixed grain, oats, rough rice, rye, sorghum, soybeans, sunflower seed, triticale, and wheat.

C. Acceptable Fumigant Formulations. EPA-registered aluminum phosphide formulations (either solid or granule) are the only approved formulations for in-transit fumigation.

D. Acceptable Fumigant Application Methods. The applied dosage must be in accordance with the EPA-registered product label and labelling. The following application methods are provided as guidelines. Although not required, it is recommended that table I of this chapter be followed to determine the best method of application for optimum results.

^{2/} A certified applicator is any individual who is certified to use or supervise the use of any restricted use pesticides covered by their certification in the CFR (40 CFR 171.2(h).)

1. Surface Treatments.

a. Spread the fumigant formulation (packaged to retain residual dust; i.e., belts, ropes, blankets, strips, sleeves, etc.) on the exposed grain surface. If possible, anchor packages to prevent shifting during transit.

b. Uniformly spread, scatter, or step pellets or tablets into the exposed grain surface.

2. Subsurface Treatments.

a. **Trenched-in.** Place fumigants (packaged to retain residual dust) in a shallow trench approximately 0.3 meters (1 foot) deep and covered with grain such that only the two ends of the package remain visible above the grain surface.

b. **Short Probe.** Use a tube constructed of polyethylene or other material, approximately 1.5 meters (5 feet) long, to apply pellets or tablets. Insert the probe into the grain to a depth of at least two-thirds of its length, fill with tablets or pellets to at least one-half of the tube's length, and then remove from the grain. Probing must be done uniformly over the entire exposed surface of the grain. Care must be taken to avoid rapid removal of the probe from the grain as this can cause the pellets or tablets to be deposited on the grain's surface. Also, bridging of the pellets or tablets within the probe must be avoided. Inserting fumigants (packaged to retain residual dust) to a depth of 1.5 meters also meets the short probe condition.

c. **Long Probe.** Use a tube of polyethylene or other material, approximately 5 meters (16 feet) long, to apply pellets or tablets. Insert the probe into the grain to a depth of at least 4 meters (13 feet). Pellets or tablets are poured into the probe, and the probe is slowly extracted from the grain. Probing must be done uniformly over the entire exposed grain surface. Bridging of the pellets or tablets within the probe must be avoided. Inserting fumigants (packaged to retain residual dust) to a depth of 4 meters also meets the long probe condition.

d. **Long Probe/Short Probe Combination.** Use at least one long probe in the four corners of the hold. Apply the remaining dose using the short probe method.

e. Tubing System. Use corrugated slotted tubing ^{3/} constructed of polyethylene or similar material with a minimum diameter of 7.6 centimeters (3 inches). Install at least two 76-meter (250 foot) lengths of the tubing prior to loading and in a manner that will provide for the uniform distribution of fumigant. Figure 1 A, B, and C illustrate three suggested installation configurations for the tubing system.

Mix approximately one-fifth to one-third of the total amount of aluminum phosphide formulation to be applied to each hold or tank with grain and pour it down the slotted tubing from the top end. Mix no more than 3,320 pellets or 664 tablets of fumigant per bushel of grain. Fill no more than two-thirds of the vertical portion of the slotted tubing with the formulation-grain mixture. After the mixture has been poured down each tube, add at least 1 bushel of grain without any formulation. The remainder of the dose may be applied by any surface or subsurface method.

f. Recirculation System. Install corrugated slotted or similar tubing in a manner that will provide for the uniform distribution of the fumigant. Attach a fan or other device to the tubing to enhance fumigant distribution. Apply fumigant using any surface or subsurface method. During transit, the fan forces the high gas concentrations in the head space to the lower portions of the hold. Figure 1 D illustrates suggested installation configuration. (Note: The fumigant industry has demonstrated the effectiveness of this system. ARS has not conducted any formal studies.)

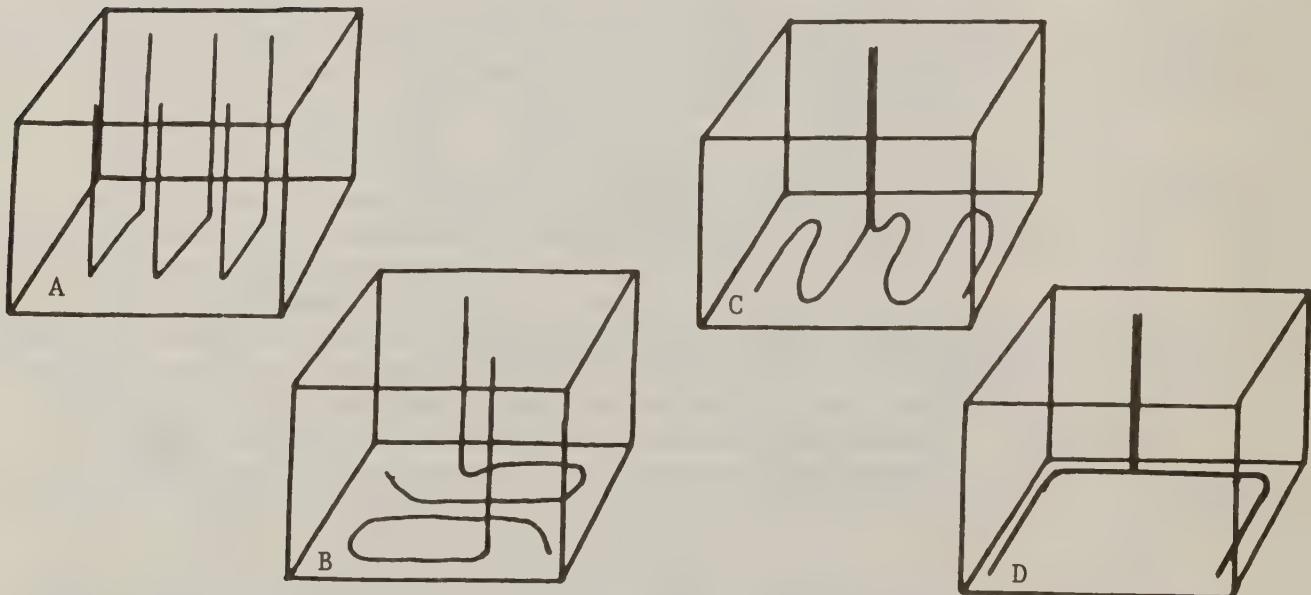


Figure 1

3/ Standard specifications for the tubing are listed in the Manual of the American Society for Testing and Materials No. F405-77a.

E. Acceptable Separation Materials. Bulk grain above or below a permeable separation material, such as burlap or woven polypropylene, may be fumigated. Bulk grain below impermeable separation materials, such as wood, plastic, or cardboard, cannot be fumigated in transit.

F. Suggested Application Methods by Commodity Depth and Exposure Time. The following table recommends specific fumigant application methods for various commodity depths and fumigant exposure time.

TABLE I

Minimum Fumigant Exposure Time
(In Days) By Commodity Depth

Application Method	Commodity Depth			
	<6 meters	6-12 meters	12-20 meters	>20 meters
Surface	9	15	Not Recommended	Not Recommended
Trench	8	15	18	Not Recommended
Short Probe	8	15	18	Not Recommended
Long/Short Probe	4	12	18	Not Recommended
Long Probe	4	10	18	Not Recommended
Tubing/Recirculation	4	7	9	9

NOTES: Holds should remain closed during entire voyage even if recommended exposure time is exceeded.

Grain depths less than 3m may be fumigated with any method with a 5-day exposure time.

2.4 PROCEDURES

The aluminum phosphide fumigant formulations may be applied to the grain aboard acceptable vessels only after the loading of the grain into the hold or tank is completed. Partially loaded or slack holds or tanks may be fumigated provided that no additional grain is subsequently loaded into that hold or tank.

When another lot of grain is to be loaded at a different elevator on top of a previous lot, the fumigant formulation may be applied only after the completion of loading all grain into the hold or tank. Certification of the first lot is withheld pending the proper application of the fumigant after completing the loading of the grain in the second lot.

The fumigated holds or tanks must remain closed for the entire voyage and should not be opened at sea unless an emergency situation exists, such as structural damage, fire, etc. Appropriate respiratory protection equipment and fumigant gas detection equipment must be on board the vessel and at least two crew members must be knowledgeable in their use.

A. Applicant's Responsibilities. The applicant for inspection must:

1. Make the necessary arrangements to secure the service of a fumigation firm with a certified applicator.

2. Follow the procedures outlined in this chapter and verify that the certified applicator follows the EPA-registered label requirements for aluminum phosphide fumigant formulations and the U.S. Coast Guard regulations regarding shipboard fumigation in the CFR (46 CFR 147A) and applicable State and local laws or regulations.

B. Certified Applicator's Responsibilities. The certified applicator must:

1. Inspect or cause to be inspected by qualified individuals the holds or tanks for suitability to retain the fumigant gas for the entire voyage. This inspection may be conducted anytime prior to fumigation. FGIS recommends the inspection be done prior to loading when the holds or tanks are empty. The vessel inspection must consider all aspects which relate to the vessel's ability to retain the fumigant for the entire voyage. Structures and systems to evaluate include, but are not limited to, the following:

a. Integrity of hatch covers, vents, manholes, and other openings to the holds or tanks. Special attention should be given to the condition of gaskets on all openings.

b. Structural or other systems that may allow the fumigant to leak from one area to another, such as coffer dams, pumping systems, all-weather tunnels, keel ducts, bilges, smoke/fire detection or suppression systems, electrical systems, deck lockers, and bulkheads and decks.

2. Identify the holds or tanks which cannot be fumigated because of their inability to retain the fumigant. Extra care must be exercised in inspecting holds or tanks that extend under the vessel's housing structure or with a common bulkhead to living quarters to ensure that no fumigant can leak into these areas.

3. Provide a written statement on the company's letterhead to FGIS or agency personnel indicating which holds or tanks are suitable for fumigation and which are not. The reason for unsuitability must be included in the statement. This statement must be signed by the certified applicator conducting the inspection and the officer in charge of the vessel. See attachment 1 for an example of this type of statement.

4. Determine the fumigant application method and the amount of fumigant to be applied to each hold or tank. Section 2.3 contains the suggested fumigant application methods by commodity depth and exposure time.

5. Conduct a prefumigation conference with the officer in charge of the vessel in the presence of FGIS or agency personnel and provide each party with a copy of the EPA-registered label from the aluminum phosphide fumigant formulation and a written statement on company letterhead (see attachment 2) signed by the certified applicator and the officer in charge of the vessel, specifying the following information:

a. The identification of the holds or tanks to be fumigated.

b. The method of application of the fumigant formulation.

c. The safety precautions to be followed by the vessel's crew during the voyage, symptoms of exposure to the fumigant, and the first-aid procedures to be followed in the event of accidental exposure.

d. That personal respiratory protection and gas detection equipment for phosphine are on board the vessel, and at least two crew members have been instructed in their use.

e. A listing of areas on the vessel that are judged to be safe and areas judged not to be safe during the fumigation.

f. A checklist of areas that must be monitored at least daily for fumigant leaks.

g. Instructions for aerating the holds or tanks. The instructions must specify that the holds or tanks must not be aerated at sea unless an emergency situation exists.

h. Instructions for the retrieval and disposal of fumigant formulation residue and its accompanying packaging, such as sachets, bag blankets, or sleeves, upon arrival at the destination port.

6. Apply the aluminum phosphide fumigant formulation. In applying the aluminum phosphide formulation, the certified applicator shall:

a. Apply the fumigant formulation at the dosage prescribed on the EPA-registered label.

b. Consider the application procedure(s) recommended in section 2.3 of this chapter based on hold depth and exposure time.

c. Close and seal all openings to the hold or tank after application of the fumigant formulation is completed.

d. Verify that the fumigant is being contained within the hold or tank and is not a hazard to the vessel's crew.

7. Install warning placards on all entrances to all fumigated holds or tanks. Placards must be placed on the **outside** of each manhatch. Each placard must exhibit the skull and crossbones symbol and include the fumigation date, fumigant formulation used, and that the fumigated hold or tanks are not to be aerated until arrival at the destination port. When possible, placards in the principal language of the crew and English should be used.

8. Provide a written statement on company letterhead (see attachment 3) to the officer in charge of the vessel and official personnel, signed by the certified applicator, indicating:

a. The date of the fumigant formulation application.

b. That the application of the fumigant formulation was in accordance with EPA, U.S. Coast Guard, and FGIS regulations and instructions.

c. The holds or tanks treated.

d. The type and quantity of fumigant formulation used in each hold or tank including the cubic capacity and the depth of each hold or tank.

e. The method of fumigant formulation application.

f. The destination of the vessel and the estimated voyage time.

g. That the openings to all fumigated spaces were closed and placarded and checked to ensure no fumigant was leaking at the time of the vessel's departure.

C. Official Personnel Responsibilities. Official personnel must:

1. Obtain a written statement on company letterhead from the certified applicator indicating which holds or tanks are suitable for fumigation based on the certified applicator's inspection as required in item B. 3. of this section.

2. Verify that the aluminum phosphide fumigant formulation has an EPA-registered label for in-transit fumigation for the type of grain to be treated.

3. Attend the prefumigation conference conducted by the certified applicator and obtain a copy of the signed statement containing the information required by item B. 5. of this section.

4. Observe the application of the fumigant formulation to verify that the dosage, method of application, sealing of the holds or tanks, and the placement of warning placards are as specified in this chapter.

5. Verify that the aluminum phosphide fumigant formulation was removed from a **factory-sealed** container. For products not always distributed in factory-sealed containers (e.g., tablets and pellets), verify that the containers are removed from sealed cartons and contain the appropriate formulation.

6. Obtain from the certified applicator a signed letterhead statement containing the information required in item B. 8. of this section.

7. Verify that all fumigated holds are closed and sealed prior to vessel departure.

8. Review all letterhead statements to ensure they contain the required information.

9. Attach a copy of all documents received to the Inspection Log (form FGIS-921).

2.5 CERTIFICATION

If the quantity of grain or rough rice initially determined to be infested or weevily is treated in accordance with this chapter, the certificate representing that quantity of grain or rough rice shall be issued as if the infested or weevily designation had never been assigned.

When, during the official inspection, insects are identified that are prohibited by the destination country or when fumigation is a quarantine requirement, the vessel may be fumigated under the provisions of this chapter. When the fumigant formulation application has been completed, FGIS will inform the Animal and Plant Health Inspection Service (APHIS) that the fumigation was conducted in accordance with FGIS procedures. APHIS will then issue a phytosanitary certificate denoting that the grain was fumigated. Additional information is contained in the APHIS/FGIS Cooperative Agreement found in FGIS Instruction 918-35, Revision 1.

2.6 QUESTIONS AND ANSWERS

The following questions and answers are designed to aid FGIS and agency personnel in interpreting the procedures contained in this chapter on in-transit shipboard fumigation of grain.

Question 1: What fumigants can be used under FGIS in-transit shipboard fumigation procedures?

Answer: Aluminum phosphide fumigant formulations registered with the U.S. Environmental Protection Agency.

Question 2: Grain being loaded aboard a bulk carrier is determined to be infested. A certified fumigator is called out to determine vessel suitability for in-transit fumigation. Can this vessel be fumigated under FGIS in-transit fumigation procedures?

Answer: Yes. The vessel must be inspected by a certified fumigator and found to be suitable for in-transit fumigation.

Question 3: Can bagged wheat be fumigated in transit under FGIS procedures?

Answer: No. Only bulk commodities can be fumigated in transit under FGIS procedures.

Question 4: A vessel registered as a 'tween decker contains car decks made of steel grating. Can this vessel be fumigated in transit under FGIS procedures?

Answer: Yes. Car decks made of steel grating will not impede the penetration of the phosphine gas. Vessels with internal decks constructed of solid steel plating or solid wood cannot be fumigated under FGIS procedures.

Question 5: Infested grain is loaded into a wing tank aboard a bulk carrier. Can the grain in the wing tank be fumigated?

Answer: Yes, if the wing tank has bleeder holes connected to the main hold or tank and the bleeder holes remain open, the main tank or hold must also be fumigated. If the wing tank has no bleeder holes or the bleeder holes are closed, only the wing tank has to be fumigated.

Question 6: The dosage for aluminum phosphide is based on the amount of grain in the hold or tank. Is this a correct statement?

Answer: No. The dosage for aluminum phosphide is always based on the cubic capacity of the hold or tanks regardless of the amount of grain actually loaded.

Question 7: Is it permissible under the provisions of this chapter to fumigate grain in one hold while loading is being completed in other holds?

Answer: Yes, providing that no additional grain is to be loaded into that fumigated hold, and the hold is sealed immediately after fumigant application. Under these situations, there is no safety hazard for official personnel. However, in many locations, longshoreman will not allow the application of the fumigant until the completion of loading of all grain aboard the vessel.

Question 8: A lot of grain is loaded into Hold Nos. 1, 2, 3, 4, 5 at Elevator A. The grain in Hold Nos. 3, 4, 5 is infested. A second lot of grain is to be loaded at Elevator B on top of this first lot. How is the fumigation conducted?

Answer: Fumigation takes place after loading of all grain into Hold Nos. 3, 4, 5. Certification of the first lot is withheld pending proper application of the fumigant after the completion of loading the grain in the second lot. Where more than one agency or field office is involved, the agency or field office performing the inspection of the first lot must inform the agency or field office that will be inspecting the second lot that infested grain is aboard the vessel and certification for the first lot is being withheld pending proper fumigant application after the completion of loading all grain into the holds or tanks in question.

2.7
FUMIGATION
CHECKLIST

The following checklist is provided to assist FGIS and agency personnel in fulfilling their responsibilities under this chapter. The use of the checklist is optional.

FGIS/Agency Fumigation Checklist

Have the following items been done:

Check One		Item
Yes	No	1. Obtained a written statement that the vessel is suitable for fumigation.
		2. Attended the prefumigation conference, and
Yes	No	a. Received a copy of EPA-registered label for the fumigant to be used.
Yes	No	b. Holds or tanks to be fumigated were identified.
Yes	No	c. The intended dose to be applied.
Yes	No	d. Method of fumigant application was described.
Yes	No	e. Voyage length was stated by the officer in charge of the vessel.
		f. Safety precautions were discussed by the certified fumigator including:
Yes	No	(1) Symptoms of exposure.
Yes	No	(2) First aid procedures.
Yes	No	(3) Two crew members were instructed in the use of respiratory protection equipment and phosphine detection equipment.
Yes	No	(4) List of areas that are judged to be safe and those judged to be unsafe for crew members during the voyage.
Yes	No	(5) Checklist of areas that must be monitored daily for phosphine leaks.
Yes	No	(6) Holds or tanks under fumigation must be closed for the entire voyage length.
Yes	No	g. Instructions for aerating the holds or tanks upon arrival at the discharge port.

Check One

Item

- | | | |
|-----|----|---|
| Yes | No | h. Instructions were provided for the retrieval and disposal of residue retention devices (bags, belts, ropes) at the discharge port. |
| Yes | No | 3. Observed the application of the fumigant. Verified accurate dose was applied and that all fumigant containers were factory sealed. |
| Yes | No | 4. The fumigant was applied by the method stated in the prefumigation conference. |
| Yes | No | 5. All openings to the holds or tanks were closed and sealed after application of the fumigant including main hatch or tank openings, man hatches, wing tank openings, butterworth plates, weep bales, and vent openings. |
| Yes | No | 6. Warning placards were installed on all entrances to the fumigated holds or tanks. |
| Yes | No | 7. Each warning placard contains the following information: date of fumigant application, fumigant formulation used, and holds or tanks must be kept closed for the entire length of the voyage. |
| Yes | No | 8. Received a written statement of fumigant application compliance from the certified applicator as required by 2.4, B(8) of the Fumigation Handbook. |

Remarks - Indicate any remarks you may have regarding the entire fumigation process.

Attachment 1
FUMIGATION HANDBOOK
Chapter 2
9-28-87

EXAMPLE OF
VESSEL SUITABILITY STATEMENT

TO: Captain or Officer In Charge of (vessel name).

I hereby certify that I have personally inspected the holds or tanks aboard the above named vessel on (date) and found the following to be true regarding the suitability of the holds or tanks for in-transit fumigation:

<u>Hold/Tank Number</u>	<u>Suitable</u>	<u>Not Suitable</u>	<u>Reason Not Suitable</u>
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Signed:
(Certified Applicator)

Acknowledged:
(Officer in Charge of the Vessel)

Attachment 2
FUMIGATION HANDBOOK
Chapter 2

EXAMPLE OF
STATEMENT OF PREFUMIGATION NOTICE COMPLIANCE

TO: Person In Charge Of (vessel name)

This is to notify you that aluminum phosphide fumigant (brand name) will be applied to the grain in Hold No(s). (hold nos.) between the hours of (hours) on (date). The fumigant will be applied as (fumigant formulation) by (method of application).

In accordance with applicable Federal, State, and local laws, the following information is provided. (Information is to be supplied by the certified applicator covering the following topics.)

- Safety precautions during voyage.
- Symptoms of exposure.
- First aid procedures.
- Checklist of areas to be monitored for fumigant leaks.
- Instructions for aerating holds or tanks.
- Instructions for retrieval and disposal of fumigant formulation residue and its accompanying packaging at the destination port.

I certify that appropriate personal respiratory protection and fumigant detection equipment for phosphine are on board the vessel and at least two crew members have been instructed in their use.

In general, the following areas of the vessel may be considered as safe during the fumigation: (list of areas)

The following areas of the vessel are not safe during the fumigation: (list of areas)

Signed:
(Certified Applicator)

Acknowledged: _____
(Vessel Captain or Person in Charge of Vessel)

Attachment 3
FUMIGATION HANDBOOK
Chapter 2
9-28-87

EXAMPLE OF
STATEMENT OF FUMIGANT APPLICATION COMPLIANCE

TO: Captain or Officer in Charge of (vessel name).

I hereby certify that aluminum phosphide fumigant formulation was applied to the grain on the above referenced vessel on (date). I further certify that the fumigant formulation application was made in accordance with U.S. Environmental Protection Agency, U.S. Coast Guard, and Federal Grain Inspection Service regulations and instructions and applicable State and local laws and regulations. The grain in the following holds or tanks was treated:

Hold/Tank Number	Hold/Tank Depth	Type and Quantity of Fumigant Formulation Used	Cubic Capacity of Hold	Method of Fumigant Application
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It is my understanding that the above named vessel is destined for (country) with an estimated voyage time of (days).

I certify that immediately following application of the fumigant formulation all openings to the fumigated space were closed and placarded with appropriate warning signs. I further certify that all openings to the fumigated space have been checked and no fumigant gas was leaking at the time of the vessel's departure.

Signed:
(Certified Applicator)

Acknowledged:
(Officer in Charge of the Vessel)

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